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Chou et al.

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[54] **HIGH-SHEAR LIQUID MIXING AND DISPERSING APPARATUS**

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[51] **Int. Cl.**[6] **B41F 31/03**; B41F 31/08

[52] **U.S. Cl.** **101/364**; 101/366

[58] **Field of Search** 101/366, 363, 101/364, 350.1, 148, 147, 355, 356, 360, 361, 365; 210/710, 711, 407, 408; 366/342, 343, 344, 103, 104, 105, 168.1, 169.1, 170.2, 170.3

[56] **References Cited**

U.S. PATENT DOCUMENTS

782,277	2/1905	Ruder .	
1,001,508	8/1911	Craig .	
1,077,882	11/1913	Holz .	
1,771,321	7/1930	Snow .	
3,138,167	6/1964	Fisher	134/145
3,638,917	2/1972	Osten	259/2
3,669,900	6/1972	Cummings .	
4,388,864	6/1983	Warner	101/148
4,523,854	6/1985	Beckley	366/132
4,571,092	2/1986	Switall	366/348
4,814,376	3/1989	Tanaka et al.	524/588
5,144,892	9/1992	Tupek et al.	101/363
5,370,824	12/1994	Nagano et al.	252/314
5,403,494	4/1995	Cain	210/710
5,511,877	4/1996	King	366/169.2
5,665,796	9/1997	Hosokawa et al.	523/322

FOREIGN PATENT DOCUMENTS

0 309 681	4/1989	European Pat. Off. .
0 355 590	2/1990	European Pat. Off. .
0 071 108	2/1993	European Pat. Off. .
23 57 212 A1	5/1975	Germany .
25 20 909	12/1975	Germany .
27 02 183 A1	7/1978	Germany .
33 19 921 A1	12/1984	Germany .
WO 96/03203	2/1996	WIPO .

OTHER PUBLICATIONS

PCT International Search Report, International Application No. PCT/US98/18205, filed Sep. 2, 1998.

TAGA Proceedings, "Theoretical and Practical Aspects of Single Fluid Lithography", Chou et al., pp. 121–139, 1995.

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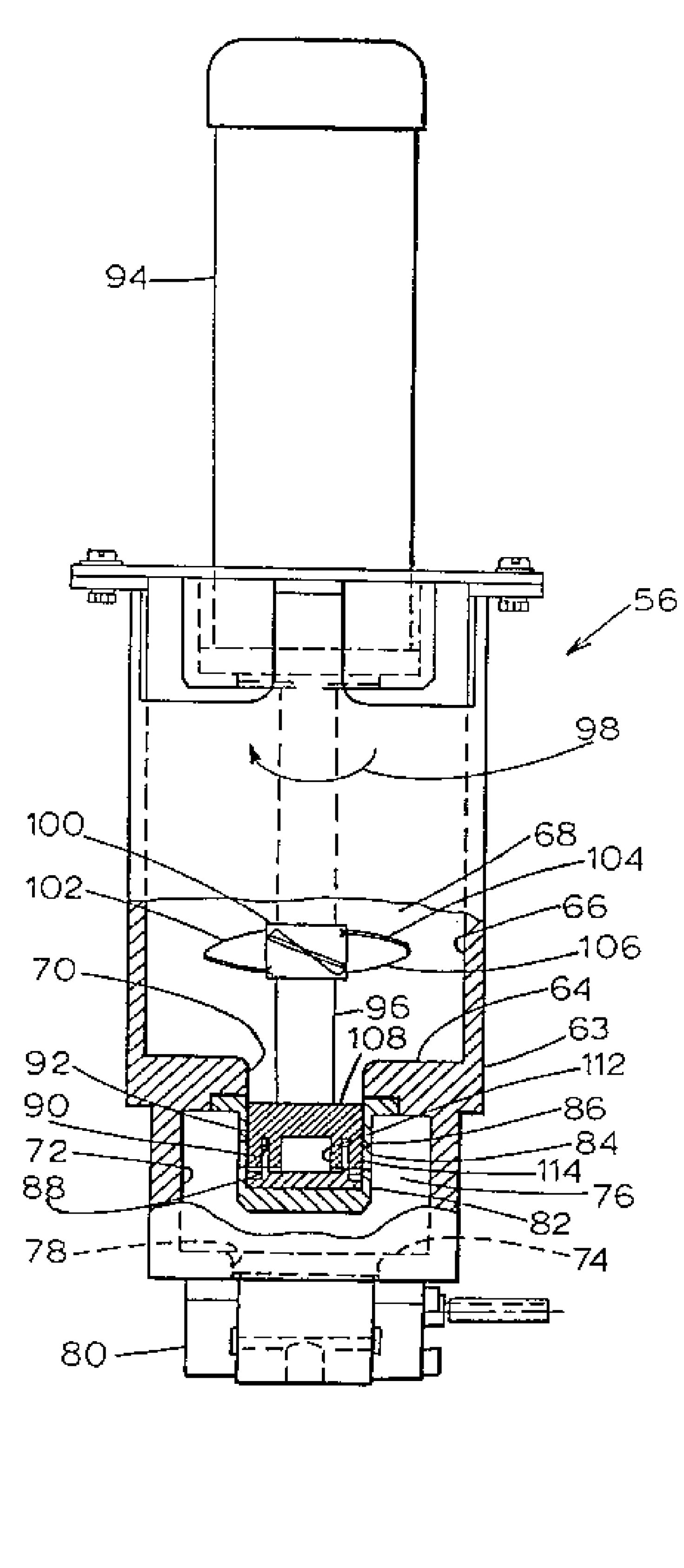
[57] **ABSTRACT**

A mixing and dispersing apparatus for emulsion ink in a printing press is disclosed. The apparatus includes a vessel having walls defining an upper chamber and a lower chamber. A motor drives a shaft carrying a propeller having pitched blades, disposed in the upper chamber. The shaft also carries a rotor disposed below the propeller. The rotor includes downwardly extending teeth that are disposed adjacent to inner and outer stator walls. The inner and outer stator walls are perforated by slots therein and are fixed with respect to the vessel. The propeller mixes ink and fountain solution and propels the mixture downward toward the rotor, which shears and disperses the ink and fountain solution into the lower chamber, forming a suitably stable emulsion ink. The emulsion ink is then pumped to an ink distribution rail for use of some of the emulsion ink for printing, with the remainder of the emulsion ink being recirculated to the mixing and dispersing apparatus.

9 Claims, 5 Drawing Sheets



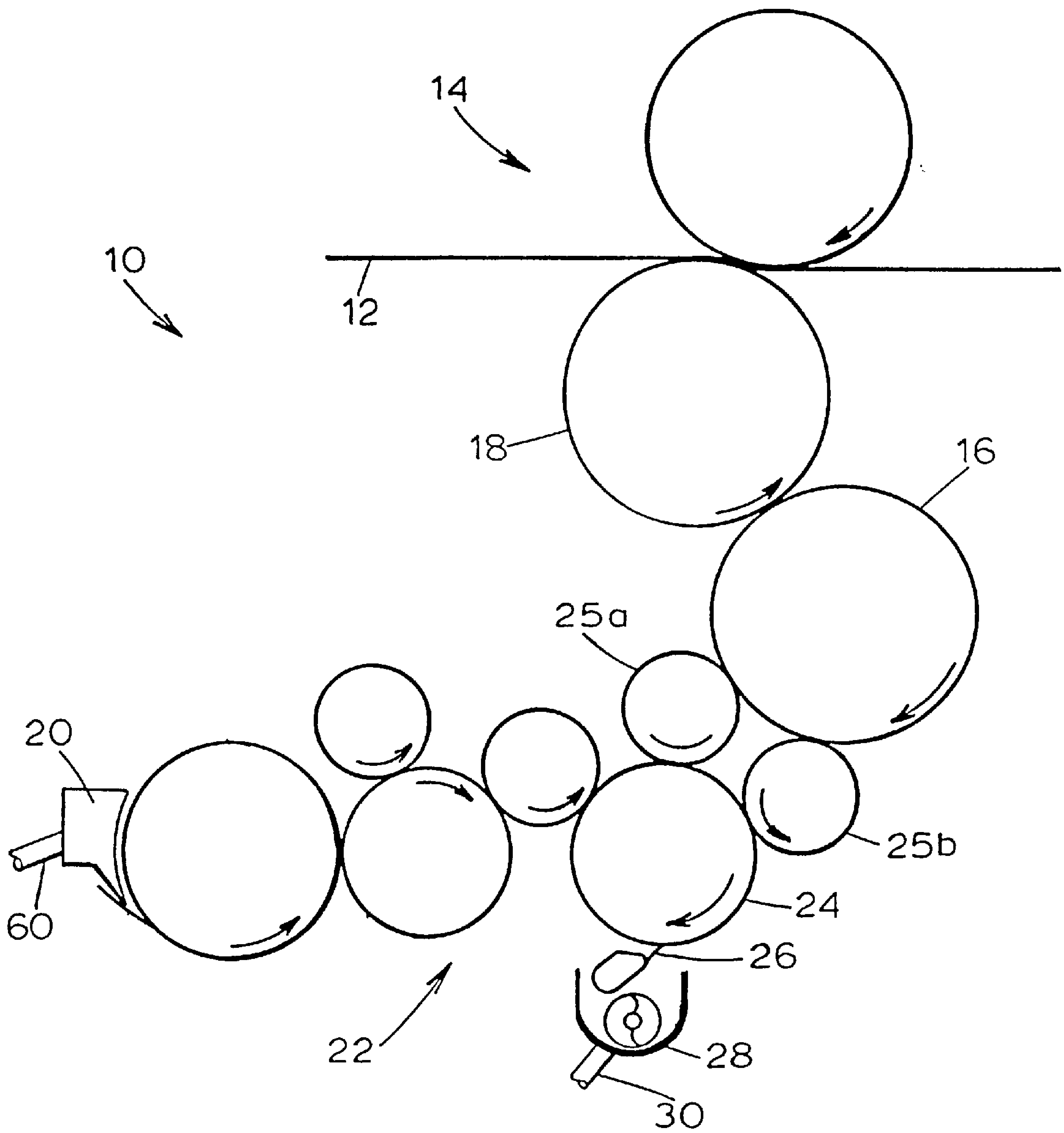
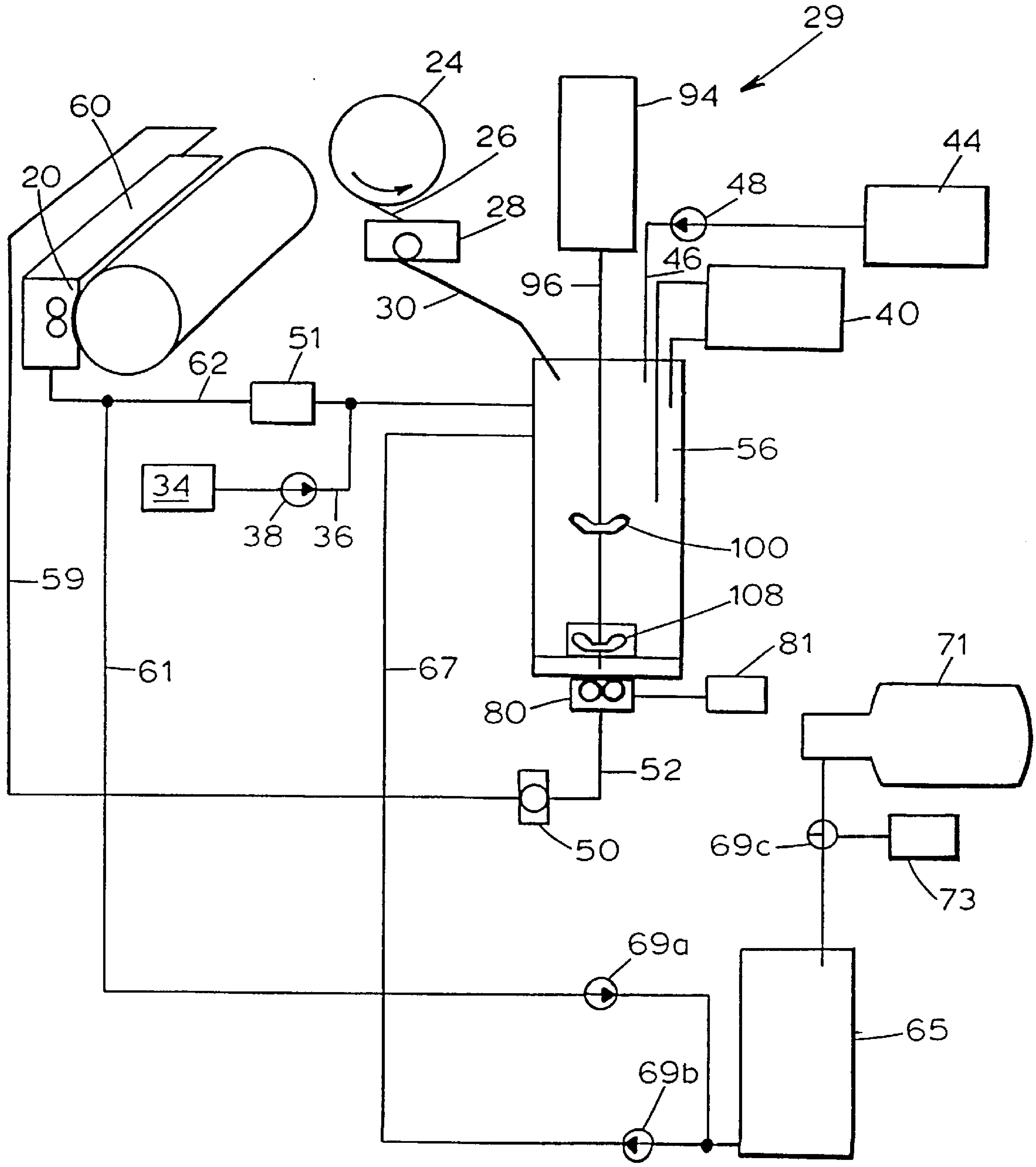


FIG. 1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94
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69c
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FIG. 2

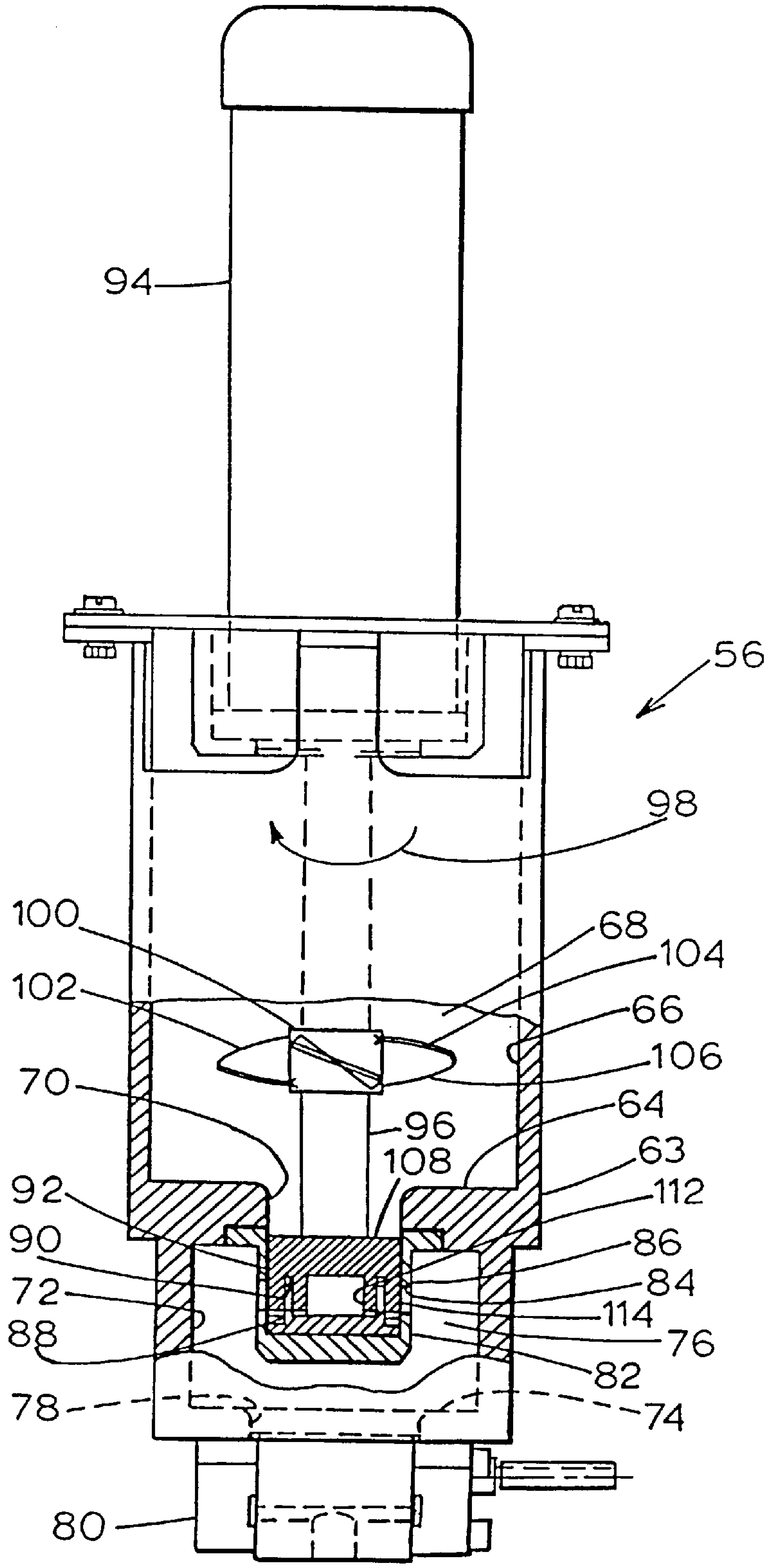
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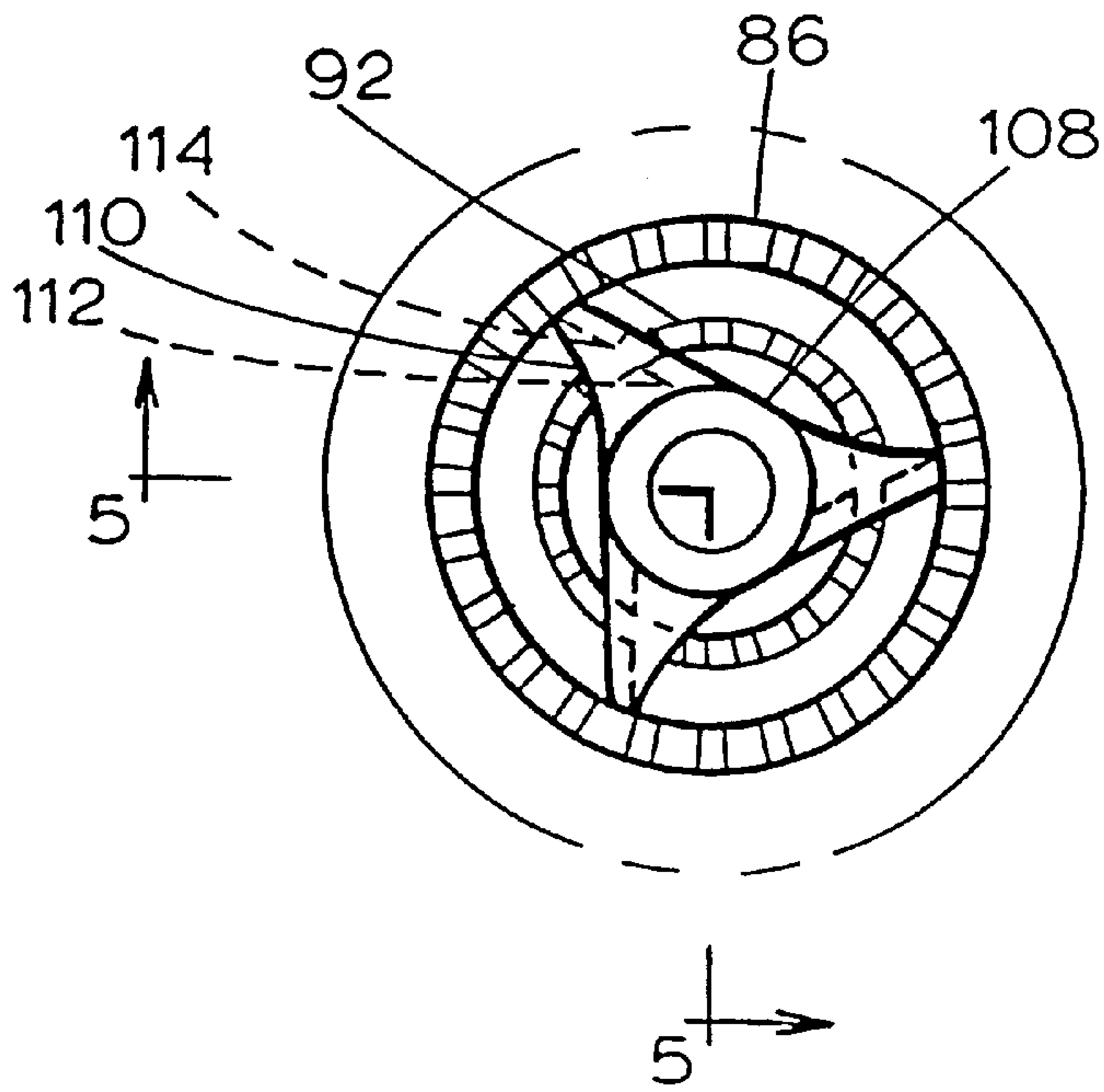
FIG. 3

FIG. 4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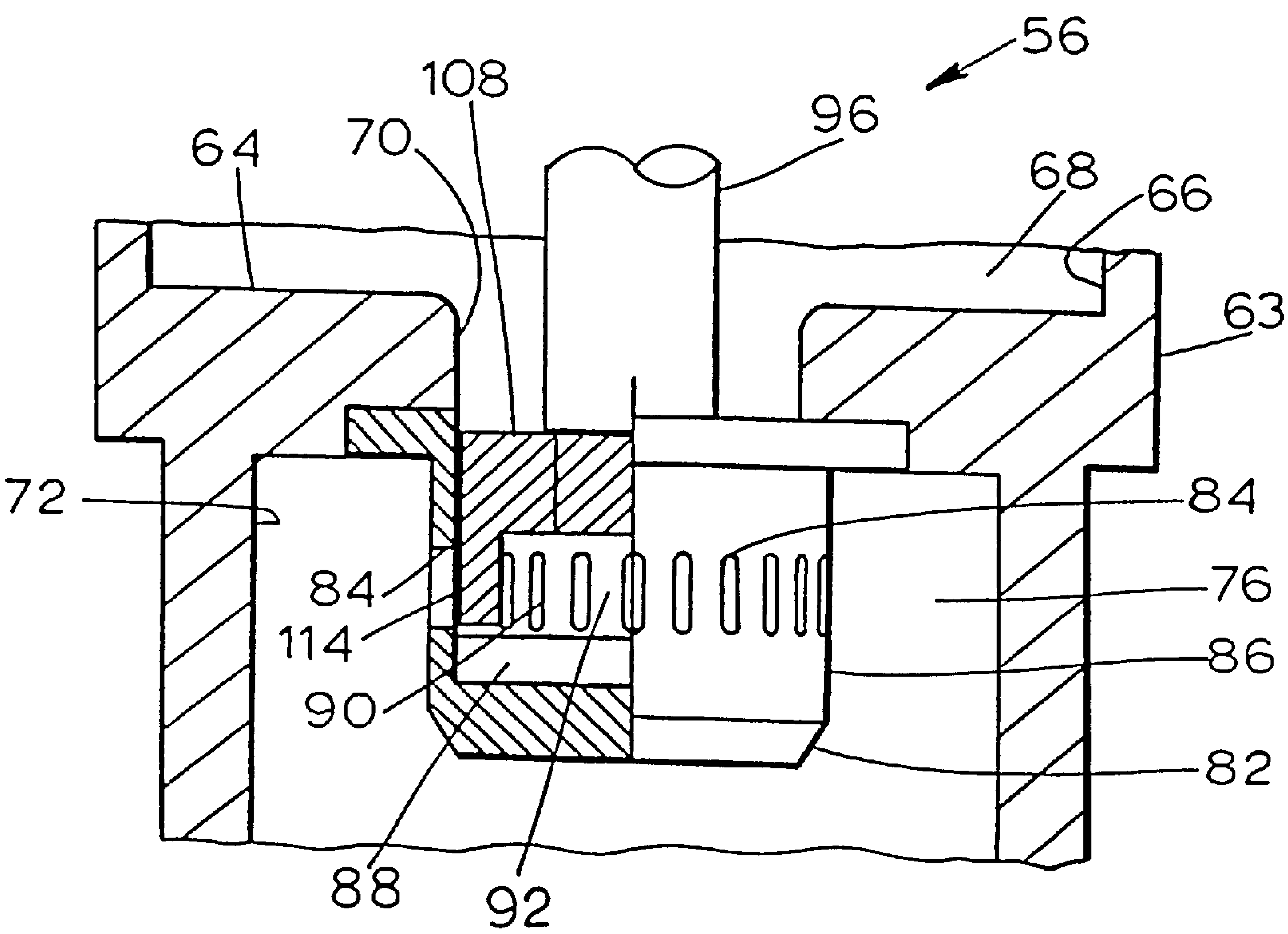
56
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FIG. 5

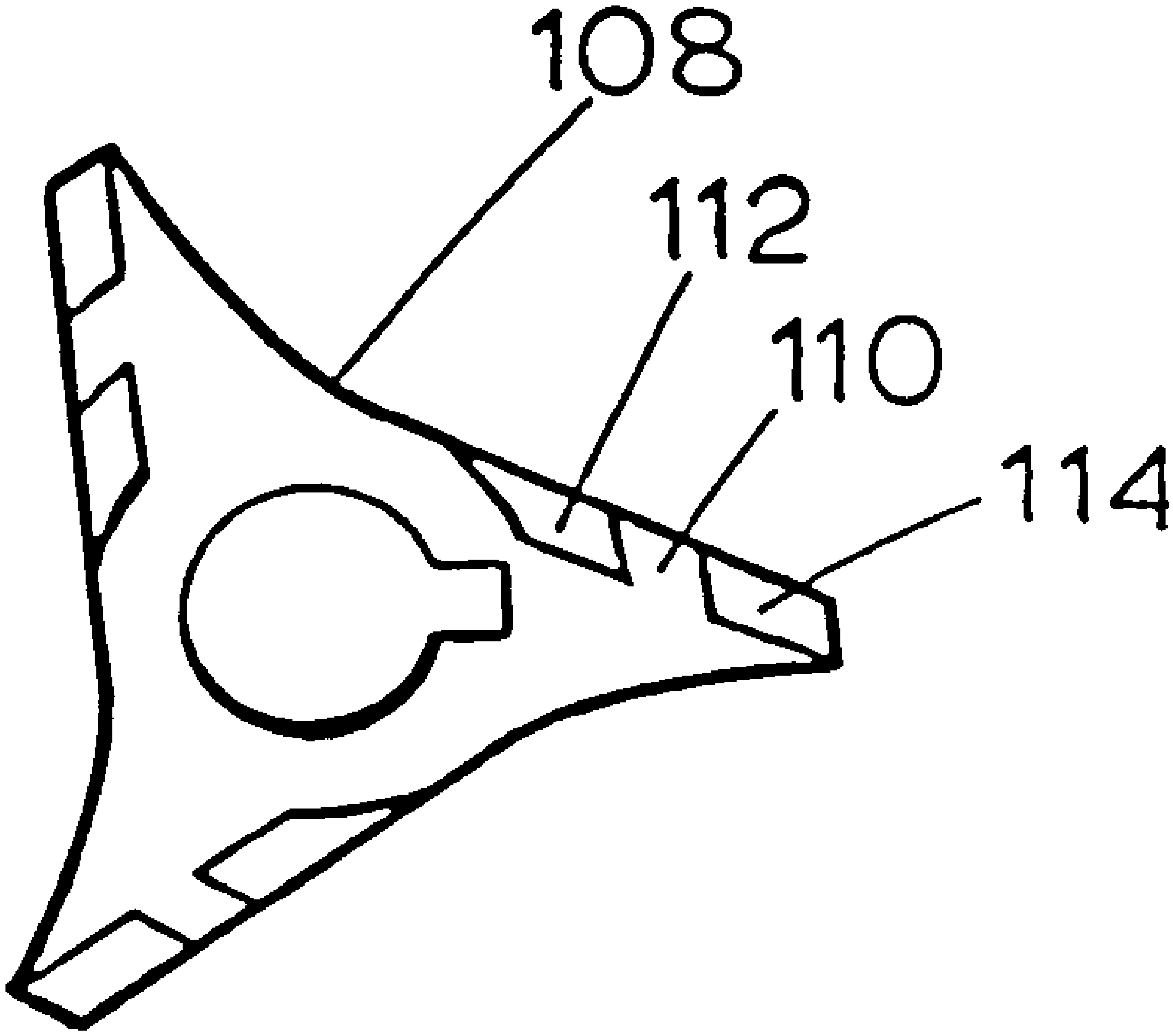

FIG. 6

HIGH-SHEAR LIQUID MIXING AND DISPERSING APPARATUS

FIELD OF THE INVENTION

The present invention is generally related to an apparatus for forming a stable liquid emulsion and, more particularly, an emulsion ink mixing and dispersing apparatus for a printing press.

BACKGROUND OF THE INVENTION

Emulsion inks used in lithography are made from an emulsion of an oil-based ink solution and a water-based fountain solution. The emulsion is applied to a printing plate (typically mounted to a plate cylinder) having distinct image areas and non-image areas. The image areas have an oleophilic material, such as an oleophilic polymer, disposed on the surface thereof, so that the oil-based ink solution will adhere thereto for subsequent transfer to a printing substrate, such as a paper web. The non-image areas have a hydrophilic material, such as an aluminum oxide, disposed on the surface thereof, so that the water-based fountain solution will adhere thereto, thereby forming a protective film over the non-image areas, to prevent ink from adhering thereto. A principal advantage of the use of emulsion inks is that emulsion inks can eliminate the need for a separate system to dampen the printing plate and hence the use of emulsion inks eliminates printing problems associated with keeping the ink and water properly in balance. Also, using emulsion inks simplifies the printing process by eliminating the need for many ink keys that would otherwise be required in presses using separate dampening and inking systems, i.e., to account for variations in image density.

However, a major drawback of the use of emulsion inks is that emulsion inks are often unstable (i.e. the oil-based ink and water-based fountain solution separate into distinct liquid layers). Such instability is undesirable because it interferes with ink transfer. For example, if the emulsion ink is not stable enough, the oil-based ink and water-based fountain solution will separate prematurely, before reaching the printing plate, resulting in scumming and wash marks, as water released from the emulsion ink will interfere with ink transfer by flushing across image areas of the printing plate. However, if the emulsion is overly stable, it will (a) not release a sufficient amount of water to the printing plate to keep the non-image areas of the printing plate free of ink and/or (b) reduce the amount of emulsion ink fed to the printing plate. Accordingly, the emulsion ink is formulated to have a stability that is within a "window" between being too stable and too unstable for satisfactory lithographic printing. It has been found that suitable emulsion inks have a water content of at least 25% by weight.

Also, because the viscosity of lithographic inks is relatively high, about 10 to a few hundred poises, lithographic inks generally do not flow freely. As water is dispersed into a matrix of lithographic ink to produce emulsion inks, the flow properties further deteriorate, making the formation of a suitably stable emulsion ink difficult.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide an apparatus for properly emulsifying a water-based liquid into an oil-based liquid. Specifically, it is an object of the present invention to provide an apparatus for mixing and dispersing an emulsion ink for lithographic printing.

In accordance with one aspect of the present invention, a liquid mixing and dispersing apparatus comprises a vessel having walls defining a chamber. An elongated rotatable shaft is disposed in the chamber. The apparatus further includes a mechanism for rotating the shaft, a mechanism associated with the shaft for mixing and propelling liquid, and a mechanism associated with the shaft for shearing and dispersing liquid.

Other objects, advantages, and features of the present invention will become apparent from a consideration of the following specification taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic diagrammatic view of a printing press incorporating an emulsion ink mixing and dispersing apparatus in accordance with the present invention;

FIG. **2** is a schematic diagrammatic view of a feed and recirculation system for the ink in the printing press of FIG. **1**;

FIG. **3** is a side elevational view, partially in cross-section, of the liquid mixing and dispersing apparatus in accordance with the present invention;

FIG. **4** is a plan view showing a rotor, an inner stator member, and an outer stator member forming part of the liquid mixing and dispersing apparatus;

FIG. **5** is a fragmentary side elevational view showing the rotor, the inner stator member, and the outer stator member, partially in cross-section taken generally along lines **5**—**5** of FIG. **4**; and

FIG. **6** is an elevational view, taken from below, showing the rotor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the illustrations given, and with reference first to FIG. **1**, there is shown a printing press generally designated **10** for printing an image on a paper web **12**. The press **10** has a printing unit **14** for printing ink on the web **12**. Although not shown, the press **10** may include one or more additional printing units that may each be used, for example, for printing a different color of ink on the web **12**.

The printing unit **14** has a plate cylinder **16** associated with a blanket cylinder **18**. During printing by the press **10**, an image of the ink is transferred from the plate cylinder **16** to the blanket cylinder **18** to print the image on one surface of the web **12**. An emulsion ink, made up of an oil-based ink and a water-based fountain solution, is fed to the plate cylinder **16** from a digitally-controlled gear pump ink injector **20** through a plurality of distribution rollers **22**, a main ink drum **24**, and a pair of form rollers **25***a* and **25***b*. The main ink drum **24** collects excess emulsion ink that is in turn scraped off of the main ink drum **24** by a doctor blade **26** and collected for reuse by an auger and scraper assembly **28**, forming part of an ink feed and recirculation system **29**, shown schematically in FIG. **2**.

With reference to FIG. **2**, the collected excess ink is transported by the auger and scraper assembly **28** to a conduit **30** which feeds a mixing and dispersing apparatus **56**. Fresh ink is fed to the mixing and dispersing apparatus **56** from an ink supply reservoir **34** through a conduit **36**. The flow of fresh ink through the conduit **36** is controlled by a valve **38** that is responsive to a liquid level sensor **40** that senses the level of liquid in the mixing and dispersing apparatus **56**. If the liquid level sensor **40** determines an overflow level of liquid, emulsion ink via conduit **62** is diverted to a conduit **61** and into an auxiliary reservoir **65**.

Liquid from the auxiliary reservoir **65** may be used again by feeding it back to the mixing and dispersing apparatus **56** via a conduit **67**. Liquid discharge into or out of the auxiliary reservoir **65** is controlled via solenoid valves **69***a*, **69***b*, and **69***c* and by air depressurizing (discharge into) or air pressurizing (discharge out of) the auxiliary reservoir **65**. The solenoid valve **69***c* can connect the auxiliary reservoir **65** to either a shop air system **71**, providing air pressure of from about 40 psi (about 276 KPa) to about 70 psi (about 483 KPa), for pressurizing the auxiliary reservoir **65**, or a vacuum source **73**, providing air at a pressure of from about 0 to about 10 psi (about 69 KPa), for depressurizing the auxiliary reservoir **65**.

Fresh fountain solution is fed to the mixing and dispersing apparatus **56** from a fountain solution supply reservoir **44** through a conduit **46**. The flow of fresh fountain solution through the conduit **46** is controlled by a valve **48** that is responsive to a water content sensor **50** that senses the percentage of water flowing out of the mixing and dispersing apparatus **56** in an outlet conduit **52**. The emulsion ink is fed to an ink distribution rail **60** via a conduit **59**. The ink distribution rail **60** in turn feeds the digitally-controlled gear pump ink injector **20**. Unused emulsion ink is continuously recirculated to the mixing and dispersing apparatus **56** via the return conduit **62**. This recirculation via the return conduit **62** is in addition to the ink scraped off of the main ink drum **24** and returned to the mixing and dispersing apparatus **56** via the conduit **30**.

A pressure regulator **51** ensures that the pressure in the conduit **62** is between about 10 psi (about 69 KPa) and about 20 psi (about 138 KPa). The pressure regulator **51** ensures that there is adequate pressure in the ink distribution rail **60** for preventing air entrainment into the ink emulsion and that there is adequate pressure for filling the auxiliary reservoir **65**, when necessary.

With reference to FIGS. **3** and **5**, the mixing and dispersing apparatus **56** includes a vessel **63** comprising a first circular horizontal wall **64**, and a cylindrically-shaped upper vertical wall **66** having a height of about 21.0 cm and an inner diameter of about 17.8 cm, that together define a cylindrically-shaped upper chamber **68**.

The first horizontal wall **64** has a circular opening **70** therein having a diameter of about 6.4 cm. The vessel **63** also includes a cylindrically-shaped lower vertical wall **72** having an inner diameter of about 13.8 cm, that is disposed directly below the first horizontal wall **64**. The first horizontal wall **64**, the cylindrically-shaped lower vertical wall **72**, and a second circular horizontal wall **74**, together define a cylindrically-shaped lower chamber **76**. The second circular horizontal wall **74** has a substantially square-shaped opening **78** therein, having dimensions of about 8.0 by 8.0 cm, that leads to a gear pump **80**, driven by a gear pump motor **81** (FIG. **2**), that pumps emulsion ink out of the lower chamber **76**.

A cup-shaped outer stator **82** is fixedly attached to the first horizontal wall **64** and is perforated by twenty four vertical slots **84** evenly distributed about an outer stator cylindrical wall **86**, having a wall thickness of about 4.8 mm. A cup-shaped inner stator **88** is fixedly attached to the outer stator **82** and is perforated by sixteen vertical slots **90** evenly distributed about an inner stator cylindrical wall **92**, having a wall thickness of about 4.0 mm. Each of the slots **84** and **90** has a height of about 15.9 mm and a width of about 3.4 mm.

A high-speed electric motor **94** is disposed above the upper chamber **68** and drives a motor shaft **96** in a clockwise direction as viewed from above, as indicated by an arrow **98**. A propeller **100** is mounted to the motor shaft **96** for rotation therewith and comprises three propeller blades **102** equally angularly spaced apart from one another by 120 degrees and each pitched by an angle of about 20 degrees with respect to the horizontal such that a leading edge **104** of each propeller blade **102** is above a respective trailing edge **106** of each propeller blade **102**. The propeller **100** has a diameter of about 12.7 cm and is mounted to the motor shaft **96** in the upper chamber **68** at a location that is preferably between one half to one full propeller diameter above the first horizontal wall **64**.

A rotor **108** (best seen in FIGS. **4** and **6**) is mounted to the lower end of the motor shaft **96** for rotation therewith. The rotor **108** includes three horizonal blades **110** that are equally angularly spaced apart from one another by 120 degrees. Each blade **110** includes a downwardly extending inner tooth **112** and a downwardly extending outer tooth **114**. Each inner tooth **112** is disposed radially inwardly of the inner stator wall **92** and each outer tooth **114** is disposed between the inner stator wall **92** and the outer stator wall **86**. A relatively close clearance of about 0.4 mm is provided between the teeth **112, 114** and the stator walls **86, 92**.

In operation, the motor **94** is rotated at a speed of between about 500 and about 4,000 revolutions per minute, and the motor shaft **96**, the rotor **108**, and the propeller **100** rotate at the same speed as the motor **94**. Due to the pitch of the propeller blades **102**, the rotation of the propeller **100** causes the ink and fountain solution in the upper chamber **68** to mix together and to flow downwardly toward the rotor **108**. The rotation of the rotor **108** shears the ink and fountain solution between the rotor teeth **112, 114** and the inner and outer stator walls **92** and **86**. This shearing causes the formation of a fine emulsion ink that is dispersed through the slots **90** and **84** in the inner and outer stator walls **92** and **86** into the lower chamber **76**. The emulsion ink is then pumped by the gear pump **80** to the conduit **57** (FIG. **2**).

The propeller **100** pre-mixes the ink and fountain solution together and ensures that the fountain solution added to the upper chamber **68** does not simply sit on top of the ink surface and fail to mix with the ink matrix to form an emulsion ink having the desired water content. The propeller **100** also prevents a cavity from forming above the rotor **108**, that would inhibit ink and fountain solution from flowing into the lower chamber **76**.

While in the foregoing there has been set forth a preferred embodiment of the invention, it will be appreciated that the details herein given may be varied by those skilled in the art without departing from the true spirit and scope of the appended claims.

We claim:

1. A liquid mixing and dispersing apparatus comprising:

a vessel having walls defining a chamber;

an elongated rotatable shaft in the chamber;

means for rotating the shaft;

means associated with the shaft for mixing and propelling liquid;

means associated with the shaft for shearing and dispersing liquid, said shearing and dispersing means including a rotor having a plurality of rotor blades, an inner rotor tooth and an outer rotor tooth, radially spaced from one another, extending from each rotor blade; and

an inner stator member, fixedly attached to the vessel and including a cylindrical inner stator wall disposed radially intermediate of the inner rotor teeth and the outer rotor teeth.

2. The apparatus of claim **1**, wherein the inner stator wall is perforated.

3. The apparatus of claim **1**, further including an outer stator member, fixedly attached to the vessel and including a cylindrical outer stator wall disposed radially outwardly of the outer rotor teeth.

4. The apparatus of claim **3**, wherein the outer stator wall is perforated.

5. An emulsion ink mixing and dispersing apparatus for a printing press, the apparatus comprising;

a vessel having walls defining an upper chamber and a lower chamber;

an elongated rotatable shaft in the upper chamber;

means for rotating the shaft;

means associated with the shaft for propelling liquid; and

means associated with the shaft for shearing and dispersing liquid, said shearing and dispersing means comprising a rotor disposed in the lower chamber that includes a plurality of rotor blades, said plurality of rotor blades including an inner rotor tooth and an outer rotor tooth, radially spaced from one another, extending from each rotor blade; and

an inner stator member, fixedly attached to the vessel and including a cylindrical inner stator wall disposed radially intermediate of the inner rotor teeth and the outer rotor teeth.

6. The apparatus of claim **5**, wherein the inner stator wall is perforated.

7. The apparatus of claim **5**, further including an outer stator member, fixedly attached to the vessel and including a cylindrical outer stator wall disposed radially outwardly of the outer rotor teeth.

8. The apparatus of claim **7**, wherein the outer stator wall is perforated.

9. The apparatus of claim **8**, wherein the perforations in the inner stator wall and the perforations in the outer stator wall provide a sole fluid path between the upper chamber and the lower chamber.

* * * * *